ARIZONA TRANSPORTATION RESEARCH CENTER

RESEARCH NOTES:

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EVALUATION OF MEASURES TO MINIMIZE WILDLIFE-VEHICLE COLLISIONS AND MAINTAIN WILDLIFE PERMEABILITY ACROSS HIGHWAYS
Arizona Route 260

Wildlife-highway relationships were studied from 2002–2006 along a 17-mile stretch of State Route (SR) 260, in central Arizona, USA. This stretch of highway is being reconstructed from a two-lane to a four-lane divided highway in five phases incorporating 11 wildlife underpasses (UP) and six bridges; seven UP and all the bridges are now complete on three reconstructed sections. Phased reconstruction allowed researchers to use a before-after-control experimental approach in their evaluation of measures designed to minimize wildlife-vehicle collisions (WVC) and promote wildlife permeability across the highway.

Study objectives

The objectives of this research project were to: 1) assess and compare wildlife use of UP, 2) evaluate elk highway permeability and movements among reconstruction classes, 3) characterize WVC patterns by reconstruction class, 4) assess relationships between highway traffic volume and elk crossing patterns when they crossed SR 260 at grade and through UP, and 5) assess the role that ungulate-proof fencing plays in WVC, wildlife use of UP, and elk highway permeability.

Assessment of wildlife underpass use

Researchers assessed and compared wildlife use of five UP using data from video camera surveillance. These camera systems were designed to capture animals approaching and crossing though UP, allowing researchers to calculate passage rates (crossings/approach). Researchers recorded 11 different wildlife species and 8,455 animals, of which elk accounted for 74%. Underpass passage rates ranged from 0.10–0.68 crossings/approach at the five UP.

Wildlife UP were highly effective in promoting below-grade wildlife crossings, with two-thirds of recorded animals having crossed through an UP. These UP were instrumental to improving highway safety through reduction of WVC and promoting wildlife permeability. Structural design characteristics and placement of UP are important considerations to maximizing their efficacy in promoting wildlife passage, and. structural characteristics were the most important factor in determining the probability of achieving successful crossings by wildlife. Underpass openness is crucial to achieving high probability of successful UP use. The distance that animals must travel through an UP is an especially important factor in maximizing efficacy and should be minimized in UP design. Elk avoided an UP where concrete mechanically stabilized earth walls were erected for soil stabilization, compared to a neighboring UP with more natural 2:1 sloped earthen sides.

Researchers documented a recurring seasonal pattern where elk UP passage rates dropped from summer levels >0.90 crossings/approach to below 0.40 during the fall when migratory elk moved through the SR 260 corridor. Migratory elk do not appear to exhibit the same propensity for habituation to UP as resident elk. Ungulate-proof fencing in conjunction with UP will expedite the wildlife learning process and help address this seasonal drop in UP passage rates.

Traffic volume and elk underpass crossings

Traffic levels on SR 260 fluctuated greatly on an hourly, daily and seasonal basis, and nearly doubled from an average annual daily traffic volume of 4,500 in 2001 to 8,700 in 2003. At the five UP where video surveillance was conducted, researchers determined if traffic levels affected elk passage rates when they approached and crossed by simultaneously counting traffic passing above UP. Passage rates at low, intermittent traffic volume (0.59–0.75 passage rate) and at higher traffic levels (0.71–0.73) did not differ from the mean passage rate determined when no vehicles were present (0.65). Passage rates varied seasonally due to the presence of migratory elk not habituated to UP, but even during migratory periods, traffic volume levels had minimal effect on passage rate. Thus, researchers found that traffic volume had no affect on elk passage rates when they crossed the highway below grade at wildlife UP. This finding was of paramount importance to understanding the efficacy of UP in promoting wildlife permeability.

Elk permeability from GPS Telemetry

Global Positioning System (GPS) telemetry afforded researchers an unprecedented opportunity to assess and compare wildlife permeability among highway reconstruction classes. In their first phase of GPS telemetry (2002–2004), researchers instrumented 33 elk with GPS receiver collars. These collars accrued 101,506 GPS fixes with 45% occurring within 0.6 mi of the highway. Nearly two times the proportion of locations occurred within 0.6 mi of the highway compared to randomly generated locations; elk were attracted to the highway corridor by riparian-meadow foraging habitats that were seven times more concentrated within the 0.6-mi zone around the highway compared to the mean proportion within elk home ranges. Elk crossed the highway 3,057 times; crossing frequency and distribution along the highway were strongly aggregated compared to a random distribution.

The mean passage rate for elk crossing the highway section where reconstruction was completed (0.43 crossings/approach) was half that of the sections under reconstruction and control sections combined (0.86). Permeability was jointly influenced by the size of the widened highway and associated vehicular traffic on all lanes. Crossing frequency was used to delineate where ungulate-proof fencing yielded maximum benefit in intercepting and funneling crossing elk toward UP and reducing elk-vehicle collisions.

Traffic volume and elk highway crossings

A permanent traffic counter was installed within the study area to provide continuous traffic data to compare to elk highway crossing data. Researchers linked 38,709 GPS locations from 44 elk collared in both telemetry phases to hourly traffic volume data (6,470,000 vehicles) to determine how elk distribution varied with traffic, and how elk highway crossings were affected by traffic volume. The probability of elk occurring near the highway decreased with increasing traffic volume, and habitat near the highway was used by elk primarily when traffic volumes were relatively low (<100 vehicles/hr). Researchers found that increasing traffic volume reduced the overall probability of at-grade elk highway crossings, but this effect depended on both season and the proximity of riparian-meadow habitats. Elk crossings occurred later in the evening when traffic levels abated, and unsuccessful attempts, or "repels" by elk to cross SR 260 at grade typically coincided with high traffic volume.

Role of ungulate-proof fencing

In their second phase of GPS telemetry (2004–2005), researchers compared permeability on one reconstructed section nearly one year before and one year after ungulate-proof fencing was erected. Researchers instrumented 22 elk with GPS receiver collars and accrued 87,745 GPS locations. The elk highway passage rate after SR 260 was opened to traffic but before fencing was erected (0.54 crossings/approach) was 32% lower than the level during reconstruction (0.79). However, once ungulate-proof fencing was erected, the passage rate increased 52% to 0.82 crossings/approach. Thus, fencing in conjunction with UP promoted wildlife permeability as animals were funneled toward UP by fencing where they crossed below grade with minimal impact from traffic (compared to crossings at grade where traffic did have an influence).

In addition to playing an instrumental role in promoting permeability, ungulate-proof fencing was crucial to achieving effective use of UP, especially those not located in proximity to meadow habitats. Without fencing, elk and deer continued to cross SR 260 at grade immediately adjacent to UP. With just 49% of one section strategically fenced to intercept peak elk highway crossings determined from GPS telemetry, an 87% reduction in EVC in the year after fencing was realized. Fencing constitutes an integral component of wildlife mitigation measures to promote permeability.

Wildlife-vehicle collision relationships

Researchers assessed spatial and temporal patterns of elk-vehicle collisions (EVC) from 1994-2006 (n = 571). They used data from their first phase of GPS telemetry to assess spatial and temporal patterns of elk highway crossings and compare to EVC patterns. Annual EVC were related to traffic volume and elk population levels. EVC occurred in a non-random pattern. Mean EVC while sections were under reconstruction (up until ungulate-proof fencing was erected; 11.6/year) was higher than before-construction EVC (4.4/year) and after reconstruction (6.5/year) EVC. On the first section completed in 2001 with limited fencing (13%), EVC did not differ among before, during, and after construction classes, even though mean traffic volume increased 67% from before- to after-construction levels, pointing to the benefit of three passage structures and fencing. On another section, EVC increased >2.5× when opened to traffic but before strategically located ungulate-proof fencing was erected along half the section; EVC dropped 87% once fencing was erected.

Researchers compared EVC and crossings at five spatial scales; the strongest relationship was at the highway section scale. Strength of the relationship and management utility were optimized at the 0.6-mi scale. The strong association between EVC and highway crossings underscored the utility and value of WVC data in planning wildlife mitigation measures ranging from passage structures to ungulate-proof fencing. EVC were associated with proximity to riparian-meadow habitats adjacent to the highway.

Though fall EVC and crossings exceeded expected levels, the proportion of EVC in September-November (49%) exceeded the proportion of crossings and coincided with the breeding season, elk migration, and high use of riparian-meadow habitats adjacent to the highway. A higher proportion of EVC (59%) occurred relative to crossings (33%) in the evening (1700-2300 hr); 34% of EVC occurred within a one-hour departure of sunset, and 55% within a two-hour departure. EVC data are valuable in developing strategies to maintain permeability and increase highway safety including locating passage structures.

Economic benefit of wildlife measures

With reconstruction of just two of the five SR 260 sections completed, integrating UP and ungulate-proof fencing, 2006 was the first year (since SR 260 reconstruction was initiated in 2000) that the incidence of actual EVC dropped below the level predicted from modeling based on traffic volume and elk population levels. Modeling predicted even greater benefit as traffic volume is anticipated to increase. The complement of measures implemented to date has achieved its objective in mitigating the impact of highway reconstruction and increasing traffic volume, and the benefit is expected to grow now that the third section is complete and the entirety of the first reconstructed section is being fenced under an enhancement grant project.

In 2006, the annual economic benefit from reduced EVC was estimated at $850,000. With only a modest increase in traffic volume, researchers estimated that the annual benefit will exceed $1 million/year.

Conclusion

This study underscored the ability to integrate transportation and ecological objectives into highway construction activities, yielding tangible benefits to highway safety and wildlife permeability, as well as economic benefits from reduced WVC. The combination of phased construction, adaptive management during reconstruction, and effective monitoring were instrumental to jointly achieving transportation and ecological objectives.

The full report: *Evaluation of Measures to Minimize Wildlife-Vehicle Collisions and Maintain Wildlife Permeability across Highways: Arizona Route 260* by Norris L. Dodd, Jeffrey W. Gagnon, Amanda Manzo, Susan Boe, and Raymond E. Schweinsburg. Arizona Game and Fish Department, Research Branch; 2221 W. Greenway Road, Phoenix, Arizona 85023 (Arizona Department of Transportation, report number FHWA-AZ-07-540, published August 2007) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.